spondence College Press:—"Algebra, The Tutorial, Part I., Elementary Course," by Rupert Deakin; "Arithmetic, The Tutorial," by W. P. Workman; "Building Construction (Science and Art)," by Brysson Cunningham; "Machine Construction, First Stage (Science and Art)," by J. Handsley Dales; "Mathematics, First Stage (Science and Art)"; "Physiography, Section One (Science and Art)," by Fabian Rosenberg; "Practical Plane and Solid Geometry, First Stage (Science and Art)," by G. F. Burn.

Mr. T. Fisher Unwin will add to his "Masters of Medicine" Series, "Thomas Sydenham," by J. F. Payne, and "Andreas Vesalius," by C. L. Taylor.

Messrs. Frederick Warne and Co. will issue new editions of:—"The Cattle Doctor," by Geo. Armatage; "Wayside and Woodland Blossoms, First and Second Series," by Edward Step.

Messrs. Wells Gardner, Darton and Co.'s list includes a new edition of "Playing at Botany," by Phœbe Allen.

Messrs. Whittaker and Co.'s announcements are:—"Periodic Classification and the Problem of Chemical Evolution," by George Rudorf; "Inspection of Railway Material," by G. R. Bodmer; "Electric Wiring Tables," by W. Perren Maycock; "Telephone System of the British Post Office," by T. E. Herbert; and "Horseless Road Locomotion," by A. R. Sennett.

MATHEMATICS AT THE BRITISH ASSOCIATION.

THE mathematical communications to this year's meeting of the British Association were made on Monday, September 10, in one of the halls assigned to the Mathematical-Physical-Astronomical Section. Major P. A. MacMahon, F.R.S., took the chair.

The committee appointed in 1888 to calculate tables of certain mathematical functions opened the proceedings by presenting a report on their year's progress. The work on which they have for some time been engaged, namely, the preparation of a new "Canon Arithmeticus," is now almost completed. The calculations have been made by Lieut.-Colonel Allan Cunningham, who, in presenting the report, announced that the liberality of the British Association and of the Royal Society had enabled the committee to undertake the publication of the tables as a separate volume. Before the Association meets next year this will probably have been given to the world, and the committee, after an existence of thirteen years, will (unless some other work is found for it) cease to exist.

Another report was taken next—this time not of a committee, but of a single worker, Miss F. Hardcastle, of Cambridge, who was commissioned two years ago to prepare an account of "The present state of the theory of point-groups" for the Association. In the absence of Miss Hardcastle, one of the secretaries stated that a first instalment of the work is to be published in this year's annual report; this, however, will give only the general classification of the subject, and an account of those memoirs on the theory of elimination which are of importance in it. The greater part of Miss Hardcastle's report will not be ready until next year.

The chair was then taken by Prof. Forsyth, while Major MacMahon read a paper on "A property of the characteristic symbolic determinant of any n quantics in n variables." Let

$$\begin{matrix} \xi_1 & \xi_2 & & \xi_n \\ a_{1x}, & a_{2x}, & \ldots & a_{nx} \end{matrix}$$

be (in symbolic notation) any n quantics in m variables, and let

$$a_{1x}\, a_{2x} \ldots a_{nx} = \ldots + C_{\xi_1 \xi_2 \ldots \xi_n}\, x_1^{\xi_1} x_2^{\xi_2} \ldots x_n^{\xi_n} + \ldots$$

Major MacMahon arrives at the remarkable result that

$$\Sigma\Sigma \ldots \Sigma C_{\xi_1 \xi_2 \ldots \xi_n}$$

(where the summation is extended over all positive integral values of $\xi_1, \xi_2, \ldots \xi_n$) has the value $\frac{(-1)^n}{f(1)}$, where $f(\theta)$ is the characteristic determinant of the umbræ $a_{11}, a_{12}, \ldots$

The next communication was made in French by Prof. Cyparissos Stephanos, of the University of Athens, "Sur les relations entre la géometrie projective et la mécanique." The fundamental thought of this paper may be explained as follows. Consider a system of forces in equilibrium. What geometrical transformations of space will transform this system into another system of forces also in equilibrium? Prof. Stephanos solves this problem, and finds that the only transformations which thus conserve equilibrium are those which, considered as performed on the Pluckerian co-ordinates of the forces, are linear and homogeneous. When the system of forces is coplanar, these transformations are homographies in the plane. This train of thought is of some importance in Graphical Statics.

Mr. H. S. Carslaw (Fellow of Emmanuel College, Cambridge) followed with a paper on "The use of multiple space in applied mathematics." The method of images, so powerful in electrostatical problems, can in its original form be applied only when the fundamental angles of the problem are submultiples of π. Prof. Sommerfeld pointed out a year or two ago that by introducing the idea of a branched space, analogous to the branched planes used in Riemann's Theory of Functions, the method of images can be freed from this limitation. Mr. Carslaw's work is an extension and development of this suggestion, which is applied by him to the solution of several of the standard problems of the potential theory.

Lieut.-Colonel Cunningham then gave some results obtained by himself and Mr. H. J. Woodall in the "Determination of successive high primes." As an example of a new process due to the authors, the factors of all numbers between 16 776 196, and 16 778 236 have been determined. 117 of the numbers in this series are found to be primes, a fact which led to some discussion on Riemann's work in the theory of prime numbers.

This was followed by a paper on "The construction of magic squares," by Dr. J. Willis, of Bradford, in which some new modes of formation were described and exemplified in diagrams. Major MacMahon then communicated two papers in succession. The first was entitled "The asyzygetic and perpetuant covariants of systems of binary quantics"; it was concerned with the extension, to a system containing any number of binary quantics, of the work which has already been done in connection with the semivariant forms of a single binary quantic.

In the second paper, "On the symbolism appropriate to the study of orthogonal and Boolian invariant systems which appertain to binary and other quantics," Major MacMahon explained a new and most remarkable method which he has discovered in the invariant theory, which promises to revolutionise the treatment of that subject. Previous writers have considered the invariant theory as consisting in the investigation of those forms associated with a quantic, which are invariant when the variables of the quantic are subjected to the general linear transformation. When the variables are subjected only to linear transformations of special types, such as the orthogonal and Boolian transformations, the family of invariant forms associated with a given quantic is, of course, much larger; but these special classes of transformations have hitherto been, comparatively speaking, ignored, as forming a tedious and outlying branch of the subject. Major MacMahon's discovery is a new symbolic method for obtaining the forms which are invariant for orthogonal and Boolian transformations, in the same way as Aronhold's symbolic method enables the investigator to obtain the forms which are invariant for the general linear transformation. Major MacMahon obtains six symbolic factors analogous to Aronhold's symbolic factors a_x and (ab), and the ordinary invariant-theory can be derived as a particular case of the new theory, by simply rejecting those forms which contain any one of a certain four of these factors.

A paper by Mr. A. B. Basset, F.R.S., in which the result that "a quintic curve cannot have more than 15 real points of inflexion"—an extension of a theorem of Zeuthen's on quartic curves—is obtained, was briefly communicated by the chairman; and a remarkably interesting session closed with two communications by Prof. J. D. Everett, F.R.S., "On Newton's contributions to central-difference interpolation," and "On a central-difference interpolation formula." In the former of these papers the author observed that certain formulæ in the calculus of finite differences, usually attributed to Stirling, were really known to Newton; in the second, a formula of interpolation was obtained which is less unsymmetrical than those generally given.

E. T. WHITTAKER.